CHAPTER

2

WQ_V REDUCTIONS AND PREFERRED SITE DESIGN PRACTICES

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2.1 Introduction

The first step in stormwater management is the site planning and design process. Development projects can be designed to reduce their impact on watersheds when efforts are made to conserve natural areas, reduce impervious cover, and better integrate stormwater treatment. By implementing a combination of these optional non-structural approaches, referred to herein as “Preferred Site Design” (PSD) practices, it is possible to reduce the amount of runoff and pollutants that are generated from a site and provide for some “non-structural” on-site treatment and control of runoff. The use of some PDSs will allow various WQ_v reductions to be granted. The goals of PSD include:

- Managing stormwater (quantity and quality) as close to the point of origin as possible and minimizing collection and conveyance;
- Preventing stormwater impacts rather than mitigating them;
- Utilizing simple, non-structural methods for stormwater management that are sometimes lower cost and lower maintenance than structural controls;
- Creating a multifunctional landscape;
- Using hydrology as the fundamental design guidance for site designs; and,
- Reducing the peak runoff rates and volumes, therefore, reducing the size and often the cost of drainage infrastructure and structural stormwater controls.

PSD for stormwater management includes a number of site design techniques such as preserving or restoring natural features and resources, effectively laying out the site elements to reduce infrastructure requirements, reducing the amount of impervious surfaces, and utilizing natural features on the site for stormwater management where possible. The objective is to reduce the “footprint” of the site while retaining and often enhancing the owner/developer’s purpose and vision for the site. Many of the PSD practices can sometimes reduce the cost of infrastructure while maintaining or even increasing the value of the property.

Reduction of adverse stormwater runoff impacts through the use of PSD practices should be the first consideration of the design engineer. Operationally, aesthetically, and often economically, the use of PSD practices offers significant benefits over treating and controlling runoff downstream. Therefore, opportunities for using these methods should be explored before considering structural stormwater controls. That said, it must be emphasized that the use of PSD practices on a project are entirely optional; they are not required.

The reduction in runoff and pollutants using PSD can reduce the required runoff peak and volumes that need to be conveyed and controlled on a site and, therefore, the size and cost of necessary drainage infrastructure and structural stormwater controls. In some cases, the use of PSD may eliminate the need for structural controls entirely. Hence, PSD practices can be viewed as both a water quantity and water quality management tool.

For some PSD practices various types of WQ_v reductions are granted. Basically, reductions provide a calculated decrease in the volume requirements for water quality protection. Section 0 describes the reduction concept and provides examples of its application.

In addition, other types of PSD practices provide avenues for reducing both hydrologic and water quality management requirements. These practices are discussed in Section 2.3.

The use of stormwater PSD practices also has a number of other ancillary benefits including:

- Possible reduction in construction costs;
- Potential for increased property values;
- More open space for recreation;
- More pedestrian friendly neighbourhoods;
- Protection of natural areas, wetlands, and habitats;
- More aesthetically pleasing and attractive landscape; and,
- Easier compliance with wetland and other resource protection regulations.

During the site planning process, there are several steps involved in site layout and design, each more clearly defining the location and function of the various components of the stormwater management system. The PSD practices can be integrated with this process as shown in Table 2-1.

Table 2-1 Integration of Preferred Site Design Practices with Site Development Process

Site Development Phase	Site Design Practice Activity
Feasibility Study	• Determine stormwater management requirements • Identify potential areas for and types of WQ_v reductions
Site Analysis	• Identify and delineate natural feature conservation areas
Concept Plan	• Preserve natural areas and stream buffers during site layout • Reduce impervious surface area through various techniques • Identify locations for use of vegetated channels and infiltration • Look for areas to disconnect impervious surfaces • Document the use of PSD practices
Preliminary and Final Plan	• Perform layout and design of WQ_v reduction areas, integrating them into treatment trains • Ensure appropriate documentation of WQ_v reductions • Develop maintenance requirements and documents
Construction	• Ensure protection of key areas • Ensure proper installation
Final Inspection	• Ensure long term protection and maintenance • Ensure WQ_v reduction areas are identified on final plan and plat

2.2 WQ_v Reductions

2.2.1 Introduction

As discussed in Chapter 1, treatment of the water quality protection volume (WQ_v) is required for all new developments or redevelopments with greater than one acre of disturbance. Calculation of the WQ_v is discussed in Chapter 4, Section 4.13. A set of WQ_v reductions is presented to provide developers and site designers with acceptable practices that can reduce the volume of stormwater runoff, including the WQ_v, and minimize the pollutant loads from a site.

Site designers are encouraged to utilize as many PSD practices as practicable on a site. Greater reductions in stormwater runoff and pollutant loading can be achieved when practices are combined into multiple systems (i.e., treatment trains). However, <u>volume reduction cannot be claimed twice for the same area of the site</u>.

The basic premise of the system is to recognize the water quality benefits of certain site design practices by allowing for a reduction in the WQ_v. If a developer incorporates one or more of the methods in the design of the site, the requirement for capture and treatment of the WQ_v will be reduced.

2.2.2 Reductions Granted

The PSD practices by which the WQ_v can be reduced are listed in Table 2-2. Site-specific conditions will determine the applicability of each reduction. For example, the stream buffer WQ_v reduction cannot be taken on upland sites that do not contain perennial or intermittent streams. (Perennial streams flow 365 days a year in a normal year. Intermittent streams have periods of time when there is no flow in a normal year but do have periods of flow during the year.)

Table 2-2 Methods to Reduce the WQ_v

Practice	Description
Reduction 1: Natural Area Conservation	Undisturbed natural areas are conserved on a site, thereby retaining their pre-development hydrologic and water quality characteristics.
Reduction 2: Vegetated Stream Buffers	Stormwater runoff is treated by directing sheet flow runoff through a naturally vegetated or wooded buffer as overland flow.
Reduction 3: Specially Engineered Vegetated Channels	Engineered vegetated channels are used to provide stormwater treatment.
Reduction 4: Overland Flow Filtration/Infiltration Zones	Overland flow filtration/infiltration zones are incorporated into the site design to receive runoff from rooftops and other small impervious areas.
Reduction 5: Environmentally Sensitive Large Lot Subdivisions	A group of site design techniques are applied to low density residential development.

Due to local constraints, soil conditions, and topography, some of these WQ_v reduction methods may be restricted. Designers are encouraged to consult with the appropriate approval authority to ensure if and when a reduction is applicable and to determine restrictions on non-structural strategies.

The methods by which the WQ_v can be reduced are detailed below. For each WQ_v reduction method, there is a set of criteria and minimum requirements that identify the conditions or circumstances under which the reduction may be applied. The intent of the numeric conditions (e.g., flow length, contributing area, etc.) is to avoid situations that could lead to a WQ_v reduction being granted without the corresponding reduction in pollution.

Reductions are primarily intended to reduce WQ_v requirements by excluding the reduction areas from the WQ_v calculations. However, reductions 1 through 4 also serve as water quality controls with Total Suspended Solids (TSS) removal benefits. Their respective TSS removal efficiencies are provided in the reduction descriptions, below.

It is important to note that site WQ_v and site TSS removal computations, although related, are performed independently. For example, the area draining to a qualifying buffer (reduction 2) is subtracted from the site area for WQ_v calculation purposes, but is still included in the site TSS removal calculation. However, the area that drains to the buffer receives 80% TSS removal in the site TSS calculation.

WQ_v Reduction #1: Natural Area Conservation

A WQ_v reduction may be taken when undisturbed stable (non-eroding) natural areas are conserved on a site, thereby retaining their pre-development hydrologic and water quality characteristics. Under this method, a designer may subtract the conservation areas from the total site area when computing the WQ_v. An added benefit is that the post-development peak discharges will be smaller, and hence, WQ_v will be reduced due to lower post-development Curve Numbers or Rational formula “C” values.

Rule: Subtract conservation areas from total site area when computing WQ_v requirements if the following criteria are met.

Criteria:

- The conservation area cannot be disturbed prior to or during project construction (or must be restored by approved methods if disturbed prior to construction), and must be protected from erosion and from sediment deposition.
- Vegetation should be native and non-invasive.
- The conservation area shall be protected by limits of disturbance clearly shown on all construction drawings.
- The conservation area shall be located within an acceptable reserve that ensures perpetual protection of the proposed area. The reserve must clearly specify how the reduction area will be managed and boundaries will be marked.

Note: Managed turf (e.g., playgrounds, regularly maintained open areas) is not an acceptable form of vegetation management.

- The conservation area shall have a minimum contiguous area requirement of 10,000 square feet.
- The conservation area can be included in the area-weighted Volumetric Runoff Coefficient (R_v) calculation.
- The conservation area must have a stable, natural ground cover.
- The conservation area is assigned a 100% TSS removal value.

Example Problem – Residential Subdivision with a Conservation Area WQ_v Reduction

A = Area = 40 acres
P = 85^{th} percentile rainfall = 1.2 inches
Natural Conservation Area = 7 acres
R_v = 0.38 (calculation method presented in Chapter 4, Section 4.13)

With Reduction:

Effective drainage area = 40 – 7 = 33 acres

$$WQ_v = \frac{P * R_v * A}{12} = \frac{1.2 * 0.38 * 33}{12} = 1.25 \text{ ac-ft}$$

Without Reduction:

$$WQ_v = \frac{1.2 * 0.38 * 40}{12} = 1.52 \text{ ac-ft}$$

Therefore, this method provides an 18% reduction in WQv in addition to the decrease in WQv due to the reduced R_v that would occur based on land use.

WQ_v Reduction #2: Vegetated Stream Buffers

A reduction for vegetated stream buffers may be taken when a stream buffer is used to treat stormwater runoff. Effective treatment requires overland flow of stormwater runoff through a naturally vegetated or wooded buffer sized in accordance with the criteria stated below. Under this method, the designer may subtract areas draining via overland flow to the buffer from the total site area when computing WQ_v requirements. The area of the buffer itself can also be subtracted if it meets the requirements of Reduction #1. The design of the stream buffer must provide a stable conveyance for flows greater than the annual recurrence (1-yr storm) event in a manner that prevents damage to the buffer.

Rule: Subtract areas draining via overland flow to the buffer from total site area when computing WQ_v requirements if the following criteria are met.

Criteria:

- The minimum undisturbed buffer width (i.e., perpendicular to the stream) shall be 50 feet from the top of bank.
- The maximum qualifying contributing length (perpendicular to the stream) shall be 150 feet for pervious surfaces and 75 feet for impervious surfaces.
- The average contributing slope shall be 3% maximum unless a flow spreader is used. (See Chapter 5 of Volume 2 for flow spreader design.)
- Runoff shall enter the buffer as overland sheet flow; a flow spreader may be installed to ensure this requirement.
- The buffer shall remain a naturally vegetated area and shall be maintained only through routine debris removal, erosion repairs, or re-planting as necessary.
- Vegetation in the buffer must be native and non-invasive.
- The buffer shall be protected during construction, and the limits of disturbance shall be clearly shown on all construction drawings, and shall be clearly defined on-site using fencing or other means.
- The buffer shall be located within a reserve that ensures perpetual protection of the proposed area. The reserve must clearly specify how the reduction area will be managed and boundaries will be marked.
- The reduction area can be included in the area-weighted R_v calculation.
- The area that drains to the buffer is assigned an 80% TSS removal value.

Example Problem – Residential Subdivision

A = Area = 40 acres
P = 85th percentile rainfall = 1.2 inches
Area draining to buffer = 4 acres
Buffer area meeting Reduction #1 requirements = 1 acre
R_v = 0.38 (calculation method presented in Chapter 4)

With Reduction:

Effective drainage area = 40 – 4 – 1 = 35 acres

$$WQ_v = \frac{P * R_v * A}{12} = \frac{1.2 * 0.38 * 35}{12} = 1.33 \text{ ac-ft}$$

Without Reduction:

$$WQ_v = \frac{1.2 * 0.38 * 40}{12} = 1.52 \text{ ac-ft}$$

Therefore, this method provides a 13% reduction in WQ_v in addition to the decrease in WQ_v due to the reduced R_v that would occur based on land use.

WQ_v Reduction #3: Specially Engineered Vegetated Channel

With Reduction #3, the designer may subtract the areas draining to a vegetated (grassed) channel provided it meets the criteria provided below. The area draining to the channel and the area of the channel itself are subtracted from total site area when computing WQ_v requirements. An added benefit is the post-development peak discharges may be lower due to a longer time of concentration for the site.

Rule: Subtract the areas draining to the engineered channel, and the area of the channel itself, from total site area when computing WQ_v requirements, if the following criteria are met.

Criteria:

- This method is only applicable to moderate or low density residential land uses (3 homes units per acre maximum).
- The maximum flow velocity in the channel for water quality design storm shall be less than or equal to 1.0 feet per second.
- The minimum residence time in the channel for the water quality storm shall be 5 minutes.
- The bottom width shall be a maximum of 6 feet. If a larger channel is needed, a compound cross section is required (see Chapter 5 of Volume 2).
- The side slopes shall be 3:1 (horizontal: vertical) or flatter.
- The channel bottom slope shall be 3 percent or less.
- The area that drains to the engineered channel is assigned an 50% TSS removal value.
- The channel shall be located within a reserve that ensures perpetual protection of the proposed channel. The reserve must clearly specify how the reduction area will be managed and boundaries will be marked.
- The reduction area is included in the area-weighted R_v calculation.

Example Problem – Residential Subdivision

Area = 40 acres
P = 85^{th} percentile rainfall = 1.2 inches
Area of channel and area draining to channel = 12.5 acres
R_v = 0.38 (calculation method presented in Chapter 4)

With Reduction:

Effective drainage area = 40 – 12.5 = 27.5 acres

$$WQ_v = \frac{P * R_v * A}{12} = \frac{1.2 * 0.38 * 27.5}{12} = 1.05 \text{ ac-ft}$$

Before Reduction:

$$WQ_v = \frac{1.2 * 0.38 * 40}{12} = 1.52 \text{ ac-ft}$$

Therefore, this method provides a 31% reduction in WQ_v if it is assumed that R_v is the same for both conditions.

WQ_v Reduction #4: Overland Flow Vegetated Filtration Areas (Commercial Developments Only)

Reduction #4 may be taken when overland flow filtration/infiltration zones are incorporated into the site design to receive runoff from small impervious areas (e.g., driveways, small parking lots, etc). This can be achieved by grading the site to promote overland vegetative filtering/infiltration. If impervious areas are adequately disconnected, they can be deducted from total site area when computing the WQ_v requirements. An added benefit is that the post-development peak discharges will likely be lower due to a longer time of concentration for the site.

Rule: If impervious areas are adequately disconnected, they can be deducted from total site area when computing the WQ_v requirements if the following criteria are met.

Criteria:

- Relatively permeable soils (hydrologic soil groups A and B) must be present in the overland flow area.
- Runoff shall not come from a hotspot land use, as defined by the local jurisdiction.
- The maximum contributing impervious flow path length shall be no greater than 75 feet.
- Downspouts shall be located at least 10 feet away from the nearest impervious surface to discourage “re-connections”.
- The disconnection area shall drain continuously overland as sheet flow through a broad grassed area or a vegetated filter strip to the property line or a downstream structural stormwater control.
- The length of the “disconnection” shall be equal to or greater than the contributing length of drainage areas.
- The entire vegetative “disconnection” shall be on a slope less than or equal to 3 percent.
- The surface impervious area draining to any one filtration zone shall not exceed 5,000 square feet.

- For those areas draining directly to a buffer, the WQ_v Reduction can be obtained from either overland flow filtration or stream buffers (See Reduction #2), but not both.
- The area shall be located within a reserve that ensures perpetual protection of the proposed area. The reserve must clearly specify how the reduction area will be managed and boundaries will be marked, and ensure that the disconnection will remain functional.
- The reduction area can be included in the area-weighted R_v calculation.
- Areas draining to these filtration zones are assigned an 80% TSS removal value.

Example Problem

Area = 3 acres
P = 85th percentile rainfall = 1.2 inches
Disconnected Impervious Area = 0.5 acres
R_v = 0.4 (calculation method presented in Chapter 4)

<u>With Reduction:</u>

Effective drainage area = 3 – 0.5 = 2.5 acres

$$WQ_v = \frac{P * R_v * A}{12} = \frac{1.2 * 0.4 * 2.5}{12} = 0.10 \text{ ac-ft}$$

<u>Without Reduction:</u>

$$WQ_v = \frac{1.2 * 0.4 * 3}{12} = 0.12 \text{ ac-ft}$$

Therefore, this method provides a 17% reduction in WQ_v for the example if it is assumed that R_v is the same for each condition.

WQ_v Reduction #5: Environmentally Sensitive Large Lot Residential Subdivisions

This reduction can be taken when a group of environmental site design techniques are applied to low density residential development (i.e., 1 dwelling unit per 2 acres or lower density). The use of this method can eliminate the need for structural stormwater controls to treat WQ_v requirements. This method is targeted towards large lot subdivisions.

Rule: Targeted towards large lot residential subdivisions (2 acre lots and greater). The requirement for structural practices to treat the WQv shall be waived if the following criteria are met.

Criteria:

The following criteria shall be recorded in covenant to ensure perpetual preservation of the features required for the reduction.

For Single Lot Development:

- The total site impervious cover for the subdivision must be equal to or less than 12%.
- The lot size for the subdivision shall be at least two acres.
- Rooftop runoff from homes shall be disconnected in accordance with the criteria in Reduction #4.
- Grass channels must be used to convey runoff, versus curb and gutter.

For Multiple Lots:

- Total impervious cover footprint shall be less than or equal to 12% of the area, including streets and driveways.
- Lot sizes must be at least 2 acres for each lot, unless clustering is implemented; open space clustered developments shall have a minimum of 25% of the site protected as natural conservation areas and shall have at least a half-acre average individual lot size, as well as meet the subdivision regulations for clustered development.
- Grass channels shall be used to convey runoff rather than curb and gutter.
- Rooftop runoff shall be disconnected in accordance with the criteria in Reduction #4.

2.3 Preferred Site Design Practices

2.3.1 Overview

This Section provides the developer and/or site engineer with detailed guidance on the use of a number of Preferred Site Design (PSD) practices. While the design practices presented here are encouraged, they are not required. A number of these practices can result in WQ_v reductions along with TSS removal benefits, as discussed previously in this chapter. These practices also reduce the hydrologic impact of a project, and thus may significantly reduce the size and cost of peak flow (flood) control facilities on the site, and may reduce the potential for adverse downstream hydrologic effects.

Preferred Site Design Practice #1:
Preserve Undisturbed Natural Areas

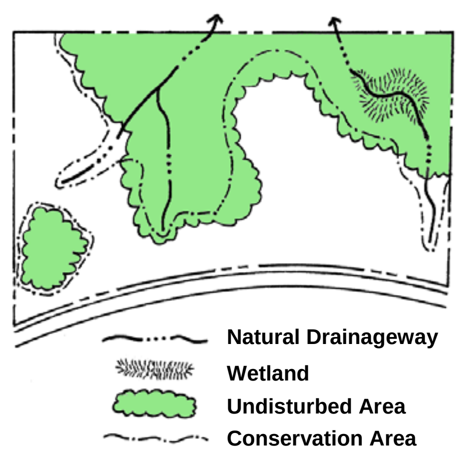
Description: Important natural features and areas such as undisturbed natural and vegetated areas, natural drainageways, stream corridors, wetlands and other important site features should be delineated and placed into conservation areas.

KEY BENEFITS	USING THIS PRACTICE
• Helps to preserve a portion of the site's natural predevelopment hydrology. • Can be used as non-structural stormwater filtering and infiltration zones. • Helps to preserve the site's natural character and aesthetic features. • A WQ_v reduction can be taken, see Reduction #1.	☑ Delineate natural areas before performing site layout and design ☑ Ensure that conservation areas are protected in an undisturbed state throughout construction and occupancy

Discussion

Preserving natural conservation areas such as undisturbed vegetated areas, natural drainageways, stream corridors and wetlands on a development site helps to preserve the original hydrology of the site and aids in reducing the generation of stormwater runoff and pollutants. Undisturbed vegetated areas also stabilize soils, provide for filtering and infiltration, decreases evaporation, and increases transpiration.

Natural conservation areas are typically identified through a site analysis using maps and aerial/satellite photography, or by conducting a site visit. These areas should be delineated before any site design, clearing or construction begins. When done before the concept plan phase, the planned conservation areas can be used to guide the layout of the site. The figure shows a site map with undisturbed natural areas delineated.



Delineation of Natural Conservation Areas

Conservation areas should be incorporated into site plans and clearly marked on all construction and grading plans to ensure equipment is kept out of these areas and native vegetation is kept in an undisturbed state. The boundaries of each conservation area should be clearly flagged so that they are not disturbed during construction.

Once established, natural conservation areas must be protected during construction and managed after occupancy by a responsible party able to maintain the areas in a natural state in perpetuity. Conservation areas are protected by legally enforceable deed restrictions, conservation reserves, and maintenance agreements. Permanent signage is required.

Preferred Site Design Practice #2:
Preserve Riparian Buffers

Description: Naturally vegetated buffers should be delineated and preserved along perennial streams, rivers, lakes, and wetlands.

KEY BENEFITS	USING THIS PRACTICE
• Can be used as non-structural stormwater filtering and infiltration zones. • Pollutant removal. • Keeps structures out of the floodplain and provides a right-of-way for large flood events. • Helps to preserve riparian ecosystems and habitats. • Streambank stabilization. • Aesthetics. • A WQ_v reduction can be taken if allowed by the local review authority per Reduction #2.	☑ Delineate and preserve naturally vegetated riparian buffers ☑ Ensure buffers and native vegetation are protected throughout construction and occupancy

Discussion

A riparian buffer is a special type of natural conservation area along a stream, wetland or shoreline where development is restricted or prohibited. The primary function of buffers is to protect and physically separate a stream, lake or wetland from future disturbance or encroachment. If properly designed, a buffer can provide stormwater management functions, can act as a right-of-way during floods, and can sustain the integrity of stream ecosystems and habitats.

Wooded riparian buffers should be maintained and re-growth should be encouraged where no wooded buffer exists. Proper restoration should include all layers of the plant community, including understory, shrubs and groundcover, not just trees. A riparian buffer can be of fixed or variable width, but should be continuous and not interrupted by impervious areas that would allow stormwater to concentrate and flow into the stream without first flowing through the buffer.

Ideally, riparian buffers should be sized to include the 100-year floodplain as well as steep banks and wetlands. The buffer depth needed to perform properly will depend on the size of the stream and the surrounding conditions. For Wichita and Sedgwick County, a minimum buffer width of 50 feet from top of bank is required in order to receive the buffer water quality reduction.

Riparian Stream Buffer

In some areas, specific local, state or federal rules may require stricter buffers than are described here. The buffer widths discussed are not intended to modify or supersede more restrictive buffer requirements already in place.

Generally, the riparian buffer should remain in its natural state. However, some maintenance is periodically necessary, such as planting to minimize concentrated flow, the removal of exotic plant species when these species are detrimental to the vegetated buffer and the removal of diseased or damaged trees.

Preferred Site Design Practice #3:
Avoid Floodplains

Description: Floodplain areas should be avoided for homes and other structures to minimize risk to human life and property damage, and to allow the natural stream corridor to accommodate flood flows.

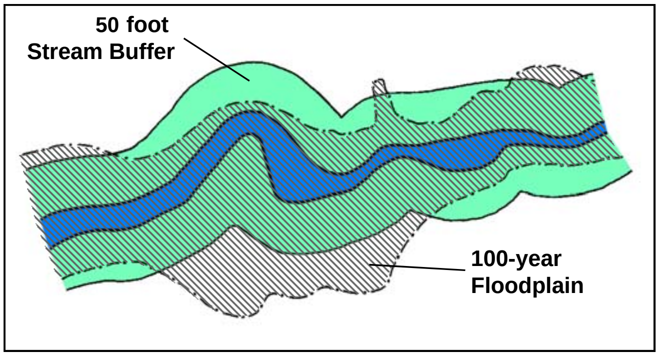
KEY BENEFITS	USING THIS PRACTICE
• Provides a natural right-of-way and temporary storage for large flood events. • Helps to keep people and structures out of harm's way. • Helps to preserve riparian ecosystems and habitats. • Can be combined with riparian buffer protection to create linear greenways.	☑ Obtain maps of the 100-year floodplain from the local review authority ☑ Ensure all development activities do not encroach on the designated floodplain areas

Discussion

Floodplains are the low-lying lands that border streams and rivers. When a stream reaches its capacity and overflows its channel during storm events, the floodplain provides for storage and conveyance of these excess flows. In their natural state they reduce flood velocities and peak flow rates. Floodplains also play an important role in reducing sedimentation by filtering runoff, and provide habitat for both aquatic and terrestrial life. Development in floodplain areas can reduce the ability of the floodplain to convey stormwater, potentially causing safety problems or significant damage to the site in question, as well as to both upstream and downstream properties. Wichita and Sedgwick County regulate the use of floodplain areas to minimize the risk to human life as well as to avoid flood damage to structures and property.

As such, floodplain areas should be avoided on a development site. Ideally, the entire 100-year full-buildout floodplain should be avoided for clearing, grading or building activities, and should be preserved in a natural undisturbed state where possible. Floodplain protection is complementary to riparian buffer preservation. Both of these PSD practices preserve stream corridors in a natural state and allow for the protection of vegetation and habitat. Depending on the site topography, 100-year floodplain boundaries may lie inside or outside a preserved riparian buffer corridor.

Maps of the 100-year floodplain can be obtained through the local review authority. Developers and builders must also ensure their site designs comply with any other relevant local floodplain and FEMA requirements.



Floodplain Boundaries in Relation to a Riparian Buffer

Preferred Site Design Practice #4:
Minimize Siting on Permeable or Erodible Soils

Description: Permeable soils such as sand and gravel provide an opportunity for groundwater recharge of stormwater runoff and should be preserved as a potential stormwater management option. Unstable or easily erodible soils should be avoided due to their greater erosion potential.

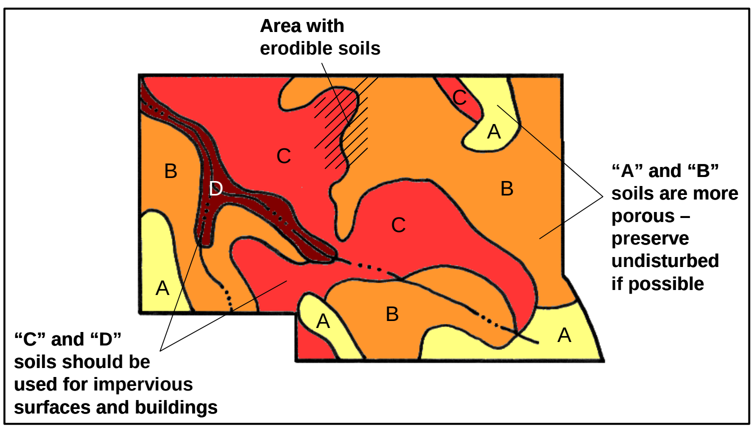
KEY BENEFITS	USING THIS PRACTICE
• Areas with highly permeable soils can be used as non-structural stormwater infiltration zones. • Avoiding highly erodible or unstable soils can prevent erosion and sedimentation problems and water quality degradation.	☑ Use soil surveys to determine site soil types ☑ Leave areas of porous or highly erodible soils as undisturbed conservation areas

Discussion

Infiltration of stormwater into the soil reduces both the volume and peak discharge of runoff from a given rainfall event, and also provides for water quality treatment and groundwater recharge. Soils with maximum permeabilities (hydrologic soil group A and B soils such as sands and sandy loams) allow for the most infiltration of runoff into the subsoil. Thus, areas of a site with these soils should be conserved as much as possible and these areas should ideally be incorporated into undisturbed natural or open space areas. Conversely, buildings and other impervious surfaces should be located on those portions of the site with the least permeable soils to the extent that soil stability, shrink-swell potential, and other soil characteristics allow.

Similarly, areas on a site with highly erodible or unstable soils should be avoided for land disturbing activities and buildings to prevent erosion and sedimentation problems as well as potential future structural problems. These areas should be left in an undisturbed and vegetated condition.

Soils on a development site should be mapped in order to preserve areas with permeable soils, and to identify those areas with unstable or erodible soils. Soil surveys can provide a considerable amount of information relating to relevant aspects of soils. General soil types should be delineated on concept site plans to guide site layout and the placement of buildings and impervious surfaces.



Soil Mapping Information can be used to Guide Development

Preferred Site Design Practice #5:
Locate Development in Less Sensitive Areas

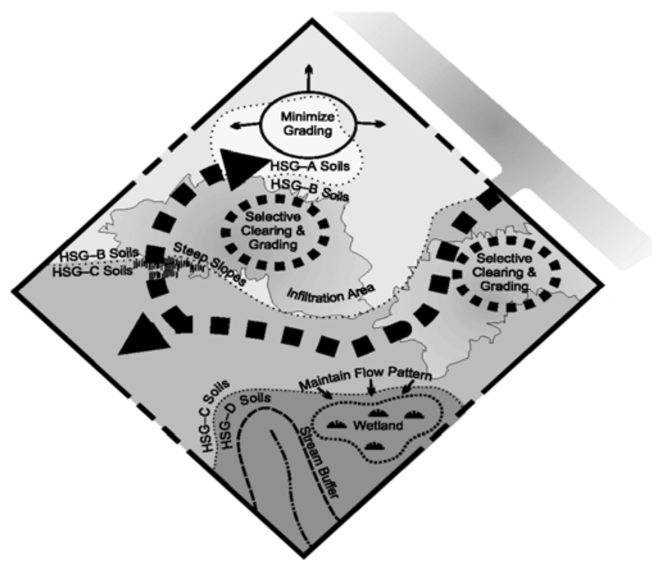
Description: To minimize the hydrologic impacts on the existing site land cover, the area of development should be located in areas of the site that are less sensitive to disturbance or have a lower value in terms of hydrologic function.

KEY BENEFITS	USING THIS PRACTICE
• Helps to preserve the natural hydrology and drainageways of a site. • Makes most efficient use of natural site features for preventing and mitigating stormwater impacts. • Provides a framework for site design and layout.	☑ Lay out the site design to minimize the hydrologic impact of structures and impervious surfaces

Discussion

A site layout should be designed so the areas of development are placed in the locations of the site that minimize the hydrologic impact of the project. This is accomplished by steering development to areas of the site that are less sensitive to land disturbance or have a lower value in terms of hydrologic function using the following methods:

- Locate buildings and impervious surfaces away from stream corridors, wetlands and natural drainageways. Use buffers to preserve and protect riparian areas and corridors.
- Areas of the site with permeable soils should be left in an undisturbed condition and/or used as stormwater runoff infiltration zones. Buildings and impervious surfaces should be located in areas with less permeable soils.
- Avoid land disturbing activities or construction on areas with steep slopes or unstable soils.
- Minimize the clearing of areas with tree canopy or thick vegetation, and ideally preserve them as natural conservation areas.
- Ensure natural drainageways and flow paths are preserved, where possible. Avoid the filling or grading of natural depressions and ponding areas.



Guiding Development to Less Sensitive Areas of a Site
(Source: Prince George's County, MD, 1999)

The figure above shows a development site where the natural features have been mapped in order to delineate the hydrologically sensitive areas. Through careful site planning, sensitive areas can be set aside as natural open space areas. In many cases, such areas can be used as buffer spaces between land uses on the site or between adjacent sites.

Preferred Site Design Practice #6:
Minimize Limits of Clearing and Grading

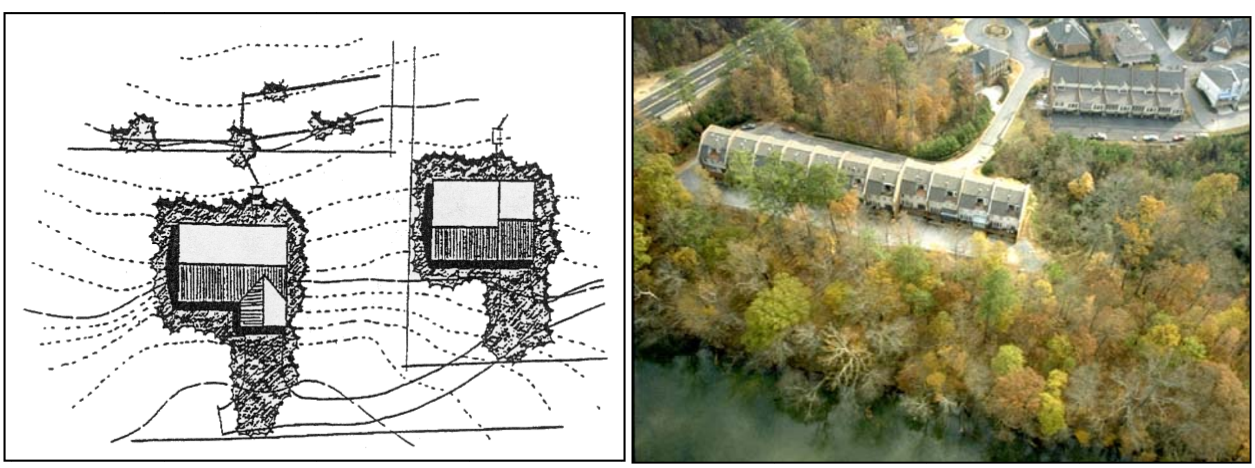
Description: Clearing and grading of the site should be limited to the minimum amount needed for the development and road access. Site footprinting should be used to disturb the smallest possible land area on a site.

KEY BENEFITS	USING THIS PRACTICE
• Preserves more undisturbed natural areas on a development site. • Techniques can be used to help protect natural conservation areas and other site features. • Minimizes runoff volumes and peaks. •	☑ Establish limits of disturbance for all development activities ☑ Use site footprinting to minimize clearing and land disturbance

Discussion

Minimal disturbance methods should be used to limit the amount of clearing and grading that takes place on a development site, preserving more of the undisturbed vegetation and natural hydrology of a site. These methods include:

- Establishing maximum limits of disturbance (LOD). These limits should reflect reasonable construction techniques and equipment needs together with the physical situation of the development site such as slopes or soils.
- Using site "footprinting" by mapping the limits of disturbance to identify the smallest possible land area on a site which requires clearing or land disturbance. Examples of site footprinting are illustrated in the figure below.
- Fitting the site design to the terrain.
- Using special procedures and equipment which reduce land disturbance.



Examples of Limits of Clearing and Site Footprinting

Preferred Site Design Practice #7:
Utilize Open Space Development

Description: Open space site designs incorporate smaller lot sizes to reduce overall impervious cover while providing more undisturbed open space and protection of water resources.

KEY BENEFITS	USING THIS PRACTICE
• Preserves conservation areas on a development site. • Can be used to preserve natural hydrology and drainageways. • Can be used to help protect natural conservation areas and other site features. • Reduces the need for grading and land disturbance. • Reduces infrastructure needs and overall development costs. • Can be used to create natural and pleasing developments. •	☑ Use a site design which concentrates development and preserves open space and natural areas of the site

Discussion

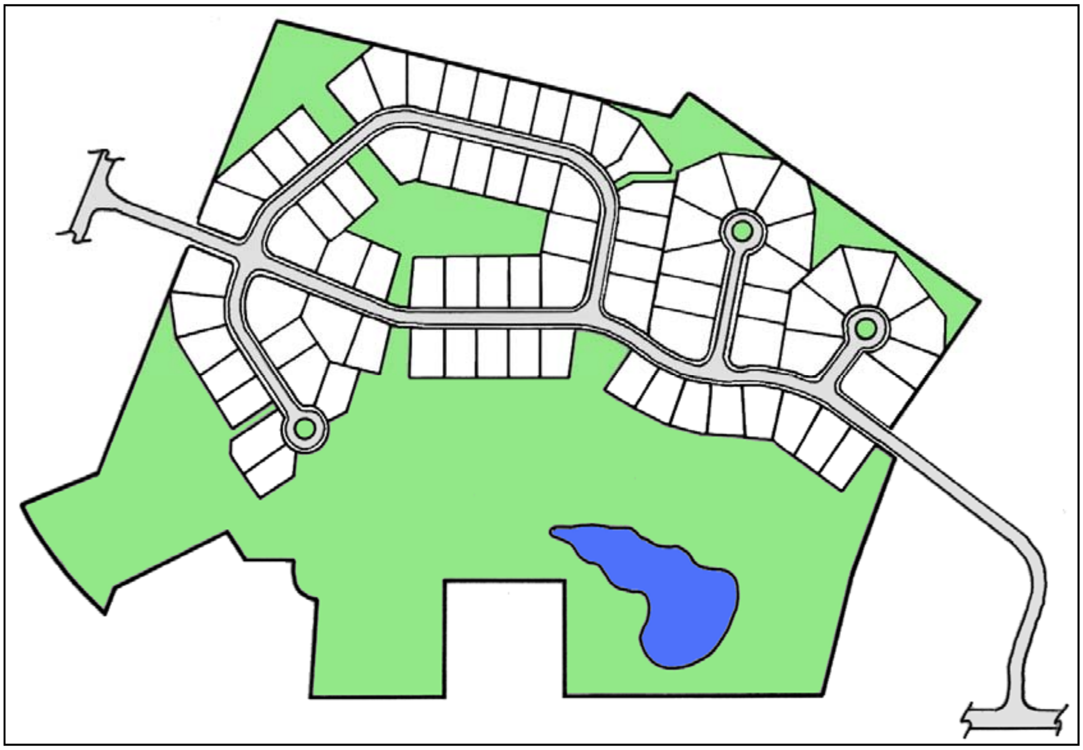
Open space development, also known as conservation development or clustering, is a site design technique that concentrates structures and impervious surfaces in a compact area in one portion of the development site in exchange for providing open space and natural areas elsewhere on the site. Typically, smaller lots and/or non-traditional lot designs are used to cluster development and create more conservation areas on the site.

Open space developments have many benefits compared with conventional commercial developments or residential subdivisions: they can reduce impervious cover, stormwater pollution, construction costs, and the need for grading and landscaping, while providing for the conservation of natural areas. The following figure shows an example of open space developments.

Along with reduced imperviousness, open space designs can provide a host of other environmental benefits lacking in most conventional designs. These developments reduce potential pressure to encroach on conservation and buffer areas because enough open space is usually reserved to accommodate these protection areas. As less land is cleared during the construction process, alteration of the natural hydrology and the potential for soil erosion are also greatly diminished. Perhaps most importantly, open space design may typically reserve 25 to 50 percent of the development site in conservation areas, which would not otherwise be protected.

Open space developments can also be significantly less expensive to build than conventional projects. Most of the cost savings are due to reduced infrastructure cost for roads and stormwater management controls and conveyances. While open space developments are frequently less expensive to build, developers also find these properties often command higher prices than those in more conventional developments. Several studies estimate that residential properties in open space developments garner premiums higher than conventional subdivisions resulting in higher selling or leasing rates.

Once established, common open space and natural conservation areas must be managed by a responsible party to maintain the areas in a natural state in perpetuity. The conservation areas are protected by legally enforceable deed restrictions, reserves, and maintenance agreements.



Open Space Subdivision Site Design Example

Preferred Site Design Practice #8:

Minimize Roadway Lengths and Widths

Description: Roadway lengths and widths should be minimized on a development site where possible to reduce overall imperviousness.

KEY BENEFITS	USING THIS PRACTICE
• Reduces the amount of impervious cover and associated runoff and pollutants generated. • Reduces the costs associated with road construction and maintenance. • May contribute to traffic calming.	☑ Consider different site and road layouts that reduce overall street length ☑ Minimize street width by using narrower street designs

Discussion

The use of alternative road layouts that reduce the total linear length of roadways can significantly reduce overall imperviousness of a development site. Site designers are encouraged to analyze different site and roadway layouts to see if they can reduce overall street length.

In addition, residential streets and private streets within commercial and other developments should be designed for the minimum required pavement width needed to support travel lanes, on-street parking, and emergency access. One-way single-lane loop roads are another way to reduce the width of lower traffic streets.

While minimizing impervious surface area is desirable, all designs must meet the minimum requirements of local codes, ordinances and regulations unless waivers are obtained from the local jurisdiction.

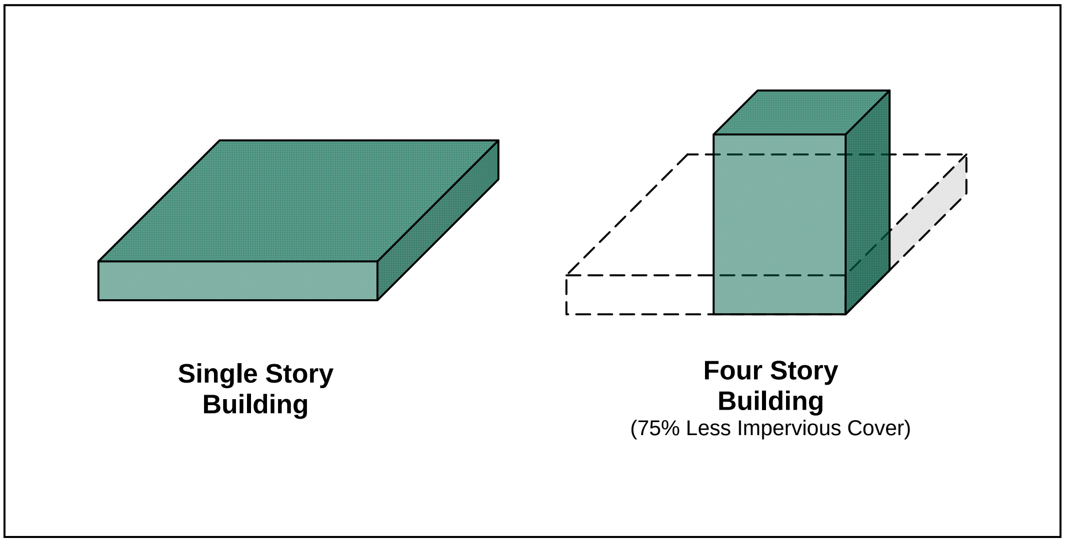
Preferred Site Design Practice #9:
Minimize Building Footprints

Description: The impervious footprint of commercial buildings and residences can be reduced by using alternate or taller buildings while maintaining the same floor to area ratio.

KEY BENEFITS	USING THIS PRACTICE
• Reduces the amount of impervious cover and associated runoff and pollutants generated. • Can result in more walkable environments. •	☑ Use alternate or taller building designs to reduce the impervious footprint of buildings

Discussion

In order to reduce the imperviousness associated with the footprint and rooftops of buildings and other structures, alternative and/or vertical (taller) building designs should be considered. The figure shows the reduction in impervious footprint by using a taller building design.



Building up rather than out can reduce the amount of impervious cover

Preferred Site Design Practice #10:
Minimize the Parking Footprint

Description: Reduce the overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, parking decks, and using porous paver surfaces or porous concrete in overflow parking areas where feasible and where soils allow for infiltration.

KEY BENEFITS	USING THIS PRACTICE
• Reduces the amount of impervious cover and associated runoff and pollutants generated. • Aesthetics. • Allows space for stormwater management and shade trees.	☑ Reduce the number of parking spaces ☑ Minimize stall dimensions ☑ Consider parking structures and shared parking ☑ Use alternative porous surface for overflow areas

Discussion

Minimizing stall dimensions, using structured parking, encouraging shared parking, minimizing the number of spaces and using alternative porous surfaces can all reduce the overall parking footprint and site imperviousness.

Sometimes parking lot designs result in far more spaces than actually required. This may be caused by a common practice of setting parking ratios to accommodate the highest hourly parking during the peak season. It may be acceptable to adopt a lower number of parking spaces and accommodate most of the demand.

Another technique to reduce the parking footprint is to minimize the dimensions of the parking spaces. This can be accomplished by reducing both the length and width of the parking stall to the minimum acceptable sizes. Parking stall dimensions can be further reduced if compact spaces are provided.

While minimizing impervious surface area is desirable, all designs must meet the minimum requirements of local codes, ordinances and regulations unless waivers are obtained from the local jurisdiction.

Construction of parking decks is one method to significantly reduce the overall parking footprint by minimizing surface parking. The following figure shows a parking deck used for a commercial development.

Parking Deck

Shared parking in mixed-use areas can further reduce the conversion of land to impervious cover. A shared parking arrangement could include usage of the same parking lot by an office space that experiences peak parking demand during the weekday with a church that experiences parking demands during the weekends and evenings.

Utilizing alternative surfaces such as porous pavers or porous concrete is an effective way to reduce the amount of runoff generated by parking lots. They can replace conventional asphalt or concrete in both new developments and redevelopment projects. The following figure is an example of porous pavers used at an overflow lot. Alternative pavers can also capture runoff from other site areas. However, porous pavement surfaces are generally more costly to construct and require more maintenance than conventional asphalt or concrete. For more specific information using these alternative surfaces, see the sections in Chapter 3 on porous pavement and modular porous paver systems. These surfaces can only be used if the soils allow for adequate infiltration, or if underdrains are provided.

Grass Paver Surface Used for Parking

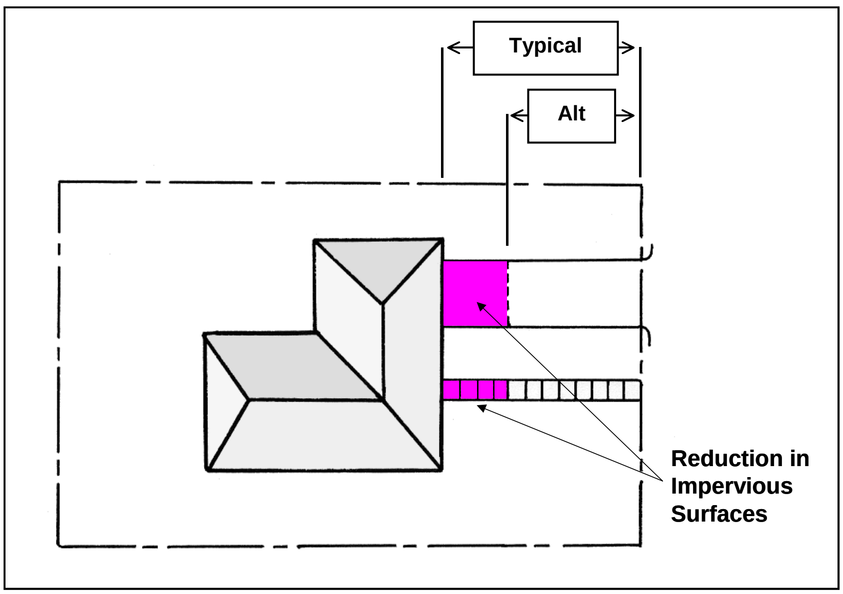
Preferred Site Design Practice #11:
Minimize Setbacks and Frontages

Description: Use smaller front and side setbacks and narrower frontages to reduce total road length and driveway lengths. This would not apply to rear access (i.e. alleys) home developments.

KEY BENEFITS	USING THIS PRACTICE
• Reduces the amount of impervious cover and associated runoff and pollutants generated. • • •	☑ Reduce building and home front and side setbacks ☑ Consider narrower frontages

Discussion

Typical building and home setbacks may be shortened (to the extent allowed by local codes, ordinances and regulations) to reduce the amount of impervious cover from driveways and entry walks (see the following figure).

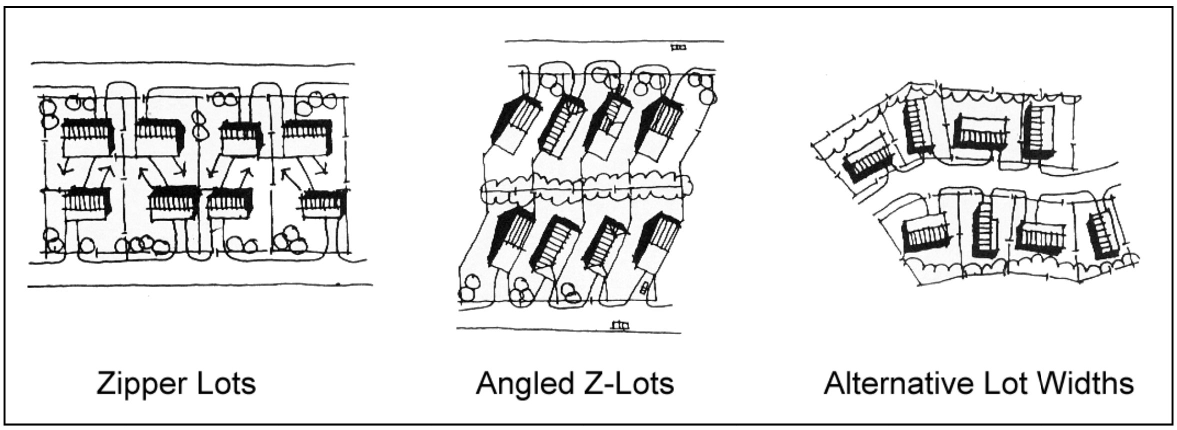


Reduced Impervious Cover by Using Smaller Setbacks
(Adapted from: MPCA, 1989)

Likewise, reducing side yard setbacks and using narrower frontages (to the extent allowable) can reduce total street length when the same number of lots are used, especially in cluster and open space designs.

Flexible lot shapes and setback and frontage distances allow site designers to create attractive and unique lots, while allowing for the preservation of natural areas in a residential subdivision. The figure below illustrates various non-traditional lot designs.

Examples of Reduced Frontages and Side Yard Setbacks



Non-traditional Lot Designs
(Source: ULI, 1992)

Preferred Site Design Practice #12:
Use Fewer or Alternative Cul-de-Sacs

Description: Minimize the number of residential street cul-de-sacs and incorporate landscaped areas to reduce their impervious cover. The radius of cul-de-sacs should be the minimum required to accommodate emergency and maintenance vehicles. Alternative turnarounds should also be considered.

KEY BENEFITS	USING THIS PRACTICE
• Reduces the amount of impervious cover and associated runoff and pollutants generated. •	☑ Consider alternative cul-de-sac designs

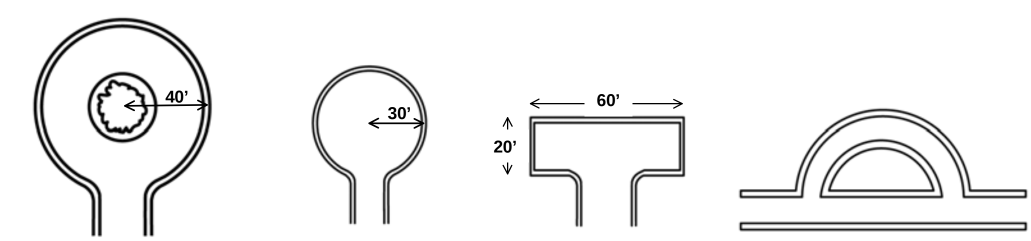
Discussion

Alternative turnarounds are designs for end-of-street vehicle turnarounds that replace traditional cul-de-sacs and reduce the amount of impervious cover created in developments. Cul-de-sacs are local access streets with a closed circular end that allows for vehicle turnarounds. From a stormwater perspective, cul-de-sacs create a huge bulb of impervious cover, increasing the amount of runoff. For this reason, reducing the size of cul-de-sacs through the use of alternative turnarounds or eliminating them altogether can reduce the amount of impervious cover created at a site.

Numerous alternatives create less impervious cover than the traditional cul-de-sac. These alternatives include reducing cul-de-sac radius and creating hammerheads, loop roads (eyebrows), and pervious islands in the cul-de-sac center (see the figure below).

Sufficient turnaround area is a significant factor to consider in the design of cul-de-sacs. In particular, the types of vehicles entering into the cul-de-sac should be considered.

While minimizing impervious surface area is desirable, all designs must meet the minimum requirements of local codes, ordinances and regulations unless a waiver is obtained from the local jurisdiction.



40 ft cul-de-sac with landscaped island **30 ft radius cul-de-sac** **60 by 20 ft T-shaped turnaround** **Loop road**

Examples of Turnarounds for Residential Streets
(Source: Schueler, 1995)

Preferred Site Design Practice #13:
Create Parking Lot Stormwater "Islands"

Description: Provide stormwater treatment for parking lot runoff using bioretention areas, filter strips, and/or other practices that can be integrated into required landscaping areas and traffic islands.

KEY BENEFITS	USING THIS PRACTICE
• Reduces the amount of impervious cover and associated runoff and pollutants generated. • Provides an opportunity for the siting of structural control facilities. • Trees in parking lots provide shading for cars and are more visually appealing.	☑ Integrate porous areas such as landscaped islands, swales, filter strips and bioretention areas in a parking lot design.

Discussion

Parking lots should be designed with landscaped stormwater management "islands" which reduce the overall impervious cover of the lot as well as provide for runoff treatment and control in stormwater facilities.

When possible, expanses of parking should be broken up with landscaped islands which include shade trees and shrubs. Fewer large islands will sustain healthy trees better than more numerous very small islands.

Structural control facilities such as filter strips, dry swales and bioretention areas can be incorporated into parking lot islands. Stormwater is directed into these landscaped areas and temporarily detained. The runoff then flows through or filters down through the bed of the facility and is infiltrated into the subsurface or collected for discharge into a stream or another stormwater facility. These facilities can be attractively integrated into landscaped areas and can be maintained by commercial landscaping firms. For detailed design specifications of filter strips, enhanced swales and bioretention areas, refer to Chapter 3.

Parking Lot Stormwater "Island"

Preferred Site Design Practice #14:
Use Vegetated Swales Instead of Curb and Gutter

Description: Where density, topography, soils, slope, and safety issues permit, vegetated open channels can be used in the street right-of-way to convey and treat stormwater runoff from roadways.

KEY BENEFITS	**USING THIS PRACTICE**
• Reduces the cost of road and storm sewer construction. • Provides for some runoff storage and infiltration, as well as treatment of stormwater. • A WQ_V reduction can be taken if designed appropriately.	☑ Use vegetated open channels (enhanced swales or grass channels) in place of curb and gutter to convey and treat stormwater runoff

Discussion

Curb and gutter and storm drain systems allow for quicker transport of stormwater from a site to a drainageway, which results in increased peak flow and reduced runoff infiltration. Curb and gutter systems also do not provide treatment of stormwater that is often polluted from vehicle emissions, pet waste, lawn runoff and litter.

Where permitted by local codes, ordinances and regulations, open vegetated channels along a roadway (see the figure below) are effective in removing pollutants by allowing infiltration and filtering to occur, unlike curb and gutter systems which move water with virtually no treatment. Grass channels and enhanced swales are two alternatives that, when properly installed and maintained under the right site conditions, are excellent methods for treating stormwater on-site. In addition, open vegetated channels can be less expensive to install than curb and gutter systems. Further design information and specifications for grass channels/enhanced swales can be found in Chapter 3.


Using Vegetated Swales instead of Curb and Gutter

Preferred Site Design Practice #15:
Drain Runoff to Pervious Areas

Description: Where practicable, direct runoff from impervious areas such as rooftops, roadways and parking lots to pervious areas, open channels or vegetated areas to provide for water quality treatment and infiltration. Avoid routing runoff directly to the structural stormwater conveyance system.

KEY BENEFITS	**USING THIS PRACTICE**
• Sending runoff to pervious vegetated areas increases overland flow time and reduces peak flows. • Vegetated areas can often filter and infiltrate stormwater runoff. • A WQ_V reduction can be taken if designed appropriately.	☑ Minimize directly connected impervious areas and drain runoff as sheet flow to pervious vegetated areas

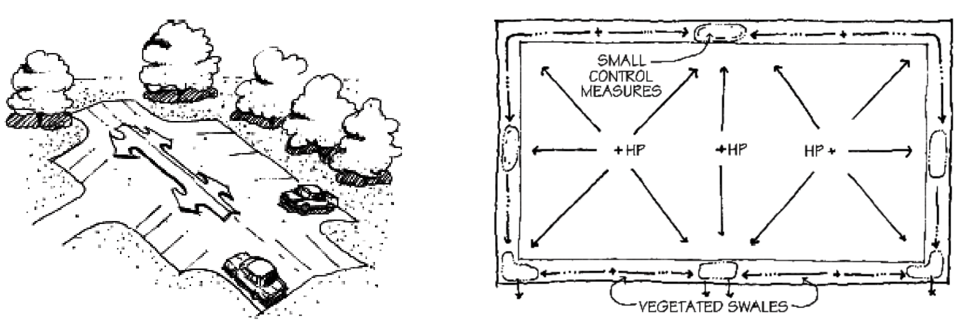
Discussion

Stormwater quantity and quality benefits can be achieved by routing the runoff from impervious areas to pervious areas such as lawns, landscaping, filter strips and vegetated channels. Revegetated areas such as lawns and engineered filter strips and vegetated channels can act as biofilters for stormwater runoff and provide for infiltration in relatively pervious (hydrologic group A and B) soils. In this way, the runoff is “disconnected” from a hydraulically efficient structural conveyance such as a curb and gutter or storm drain system.

Some of the methods for disconnecting impervious areas include:

- Designing roof drains to flow to vegetated areas or infiltration areas;
- Directing flow from paved areas (such as driveways) to stabilized vegetated areas;
- Breaking up flow directions from large paved surfaces (see the figure below);
- Carefully locating impervious areas and grading landscaped areas to achieve sheet flow runoff to the vegetated pervious areas.

For maximum benefit, runoff from impervious areas to vegetated areas must occur as sheet flow and the soil must be stabilized. See Chapter 3 for more design information and specifications on filter strips and vegetated channels.



Design paved surfaces to disperse flow to vegetated areas
(Source: NCDENR, 1998)

2.4 Preferred Site Design Examples

2.4.1 Residential Subdivision Example 1

A typical residential subdivision design on a parcel is shown in upper Figure 2-1. The entire parcel except for the subdivision amenity area (clubhouse and tennis courts) is used for lots. The entire site is cleared and mass graded, and no attempt is made to fit the road layout to the existing topography. Because of the clearing and grading, all of the existing natural vegetation and topsoil are removed, dramatically altering both the natural hydrology and drainage of the site. The wide residential streets create unnecessary impervious cover and a curb and gutter system that carries stormwater flows to the storm sewer system. No provision for non-structural stormwater treatment is provided on the subdivision site.

A residential subdivision employing Preferred Site Design (PSD) practices is presented in lower Figure 2-1. This subdivision configuration preserves approximately one-fourth of the property as undisturbed open space and vegetation. The road layout is designed to fit the topography of the parcel, following the high points and ridgelines. The natural drainage patterns of the site are preserved and are utilized to provide natural stormwater treatment and conveyance. Narrower streets reduce impervious cover and grass channels provide for treatment and conveyance of roadway and driveway runoff. Landscaped islands at the ends of cul-de-sacs also reduce impervious cover and provide stormwater treatment functions. Where possible, only the building envelopes of the individual lots are cleared and graded, further preserving the natural hydrology of the site.

2.4.2 Residential Subdivision Example 2

Another typical residential subdivision design is shown in upper Figure 2-2. Most of this site is cleared and mass graded, with the exception of a small riparian buffer along the large stream at the right boundary of the property. Almost no buffer was provided along the small stream that runs through the middle of the property. In fact, areas within the 100-year floodplain were cleared and filled for home sites. As is typical in many subdivision designs, this one has wide streets for on-street parking and large cul-de-sacs.

The PSD subdivision can be seen in lower Figure 2-2. This subdivision layout was designed to conform to the natural terrain. The street pattern consists of a wider main thoroughfare, which winds through the subdivision along the ridgeline. Narrower loop roads branch off of the main road and utilize landscaped islands. Large riparian buffers are preserved along both the small and large streams. The total undisturbed conservation area is approximately one-third of the site.

2.4.3 Commercial Development Example

Upper Figure 2-3 shows a typical commercial development containing a supermarket, drugstore, smaller shops and a restaurant on an outlot. The majority of the parcel is a concentrated parking lot area. The only pervious area is a small replanted vegetation area acting as a buffer between the shopping center and adjacent land uses. Stormwater quality and quantity control are provided by a wet extended detention pond in the corner of the parcel.

A PSD commercial development can be seen in lower Figure 2-3. Here the retail buildings are dispersed on the property, providing more of an “urban village” feel with pedestrian access between the buildings. The parking is broken up, and bioretention areas for stormwater treatment are built into parking lot islands. A large bioretention area which serves as open green space is located at the main entrance to the shopping center. A larger undisturbed buffer has been preserved on the site. Because the bioretention areas and buffer provide the required water quality treatment, only a dry extended detention basin is needed for water quantity control.

2.4.4 Office Park Example

An office park with a conventional design is shown in upper Figure 2-4. Here the site has been graded to fit the building layout and parking area. All of the vegetated areas of this site are replanted areas.

The PSD layout, presented in lower Figure 2-4, preserves undisturbed vegetated buffers and open space areas on the site. Both the parking areas and buildings have been designed to fit the natural terrain of the site. In addition, a modular porous paver system is used for the overflow parking areas.

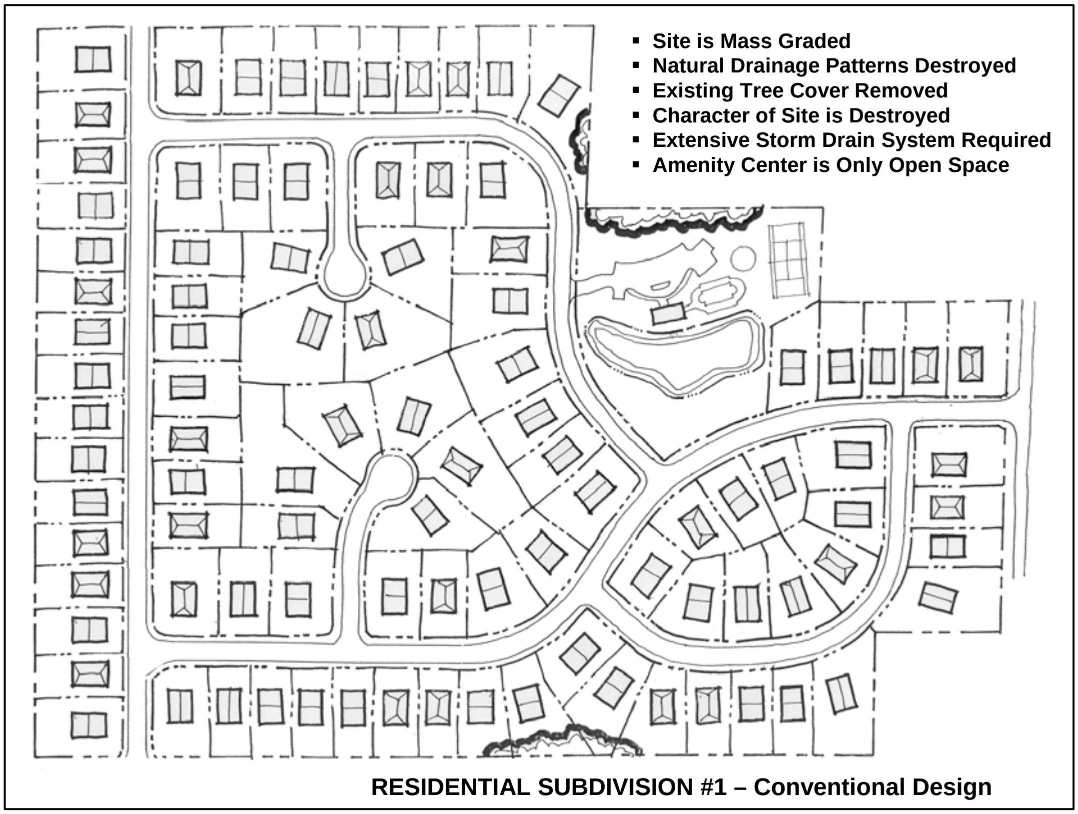
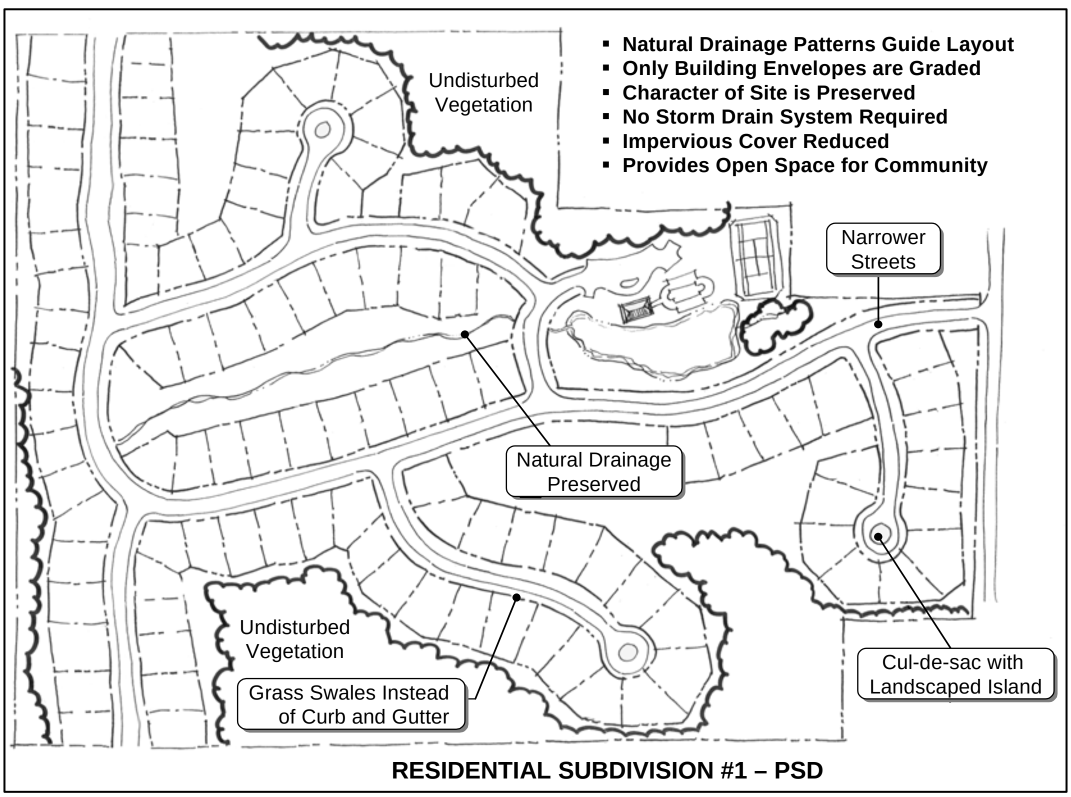
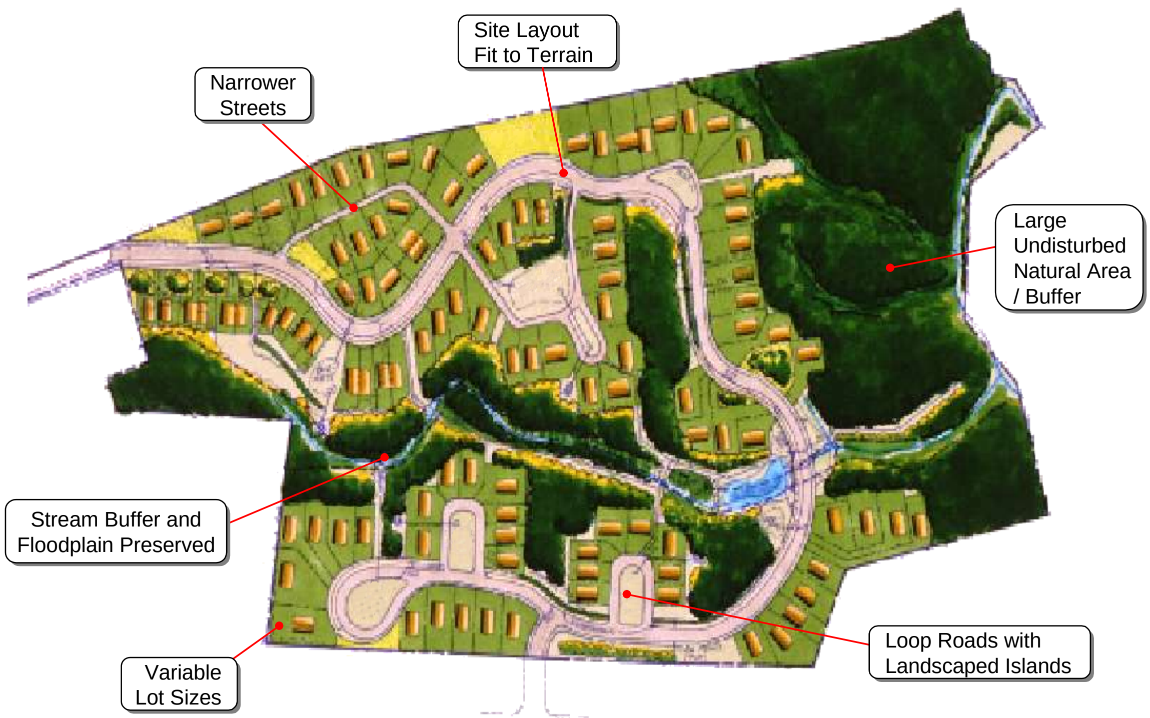


Figure 2-1 Comparison of a Traditional Residential Subdivision Design (above) with and Innovative Site Plan Developed Using Preferred Site Design Practices (below)



RESIDENTIAL SUBDIVISION #2 – Conventional Design

Figure 2-2 Comparison of a Traditional Residential Subdivision Design (above) with an Innovative Site Plan Developed Using Preferred Site Design Practices (below)



RESIDENTIAL SUBDIVISION #2 – PSD

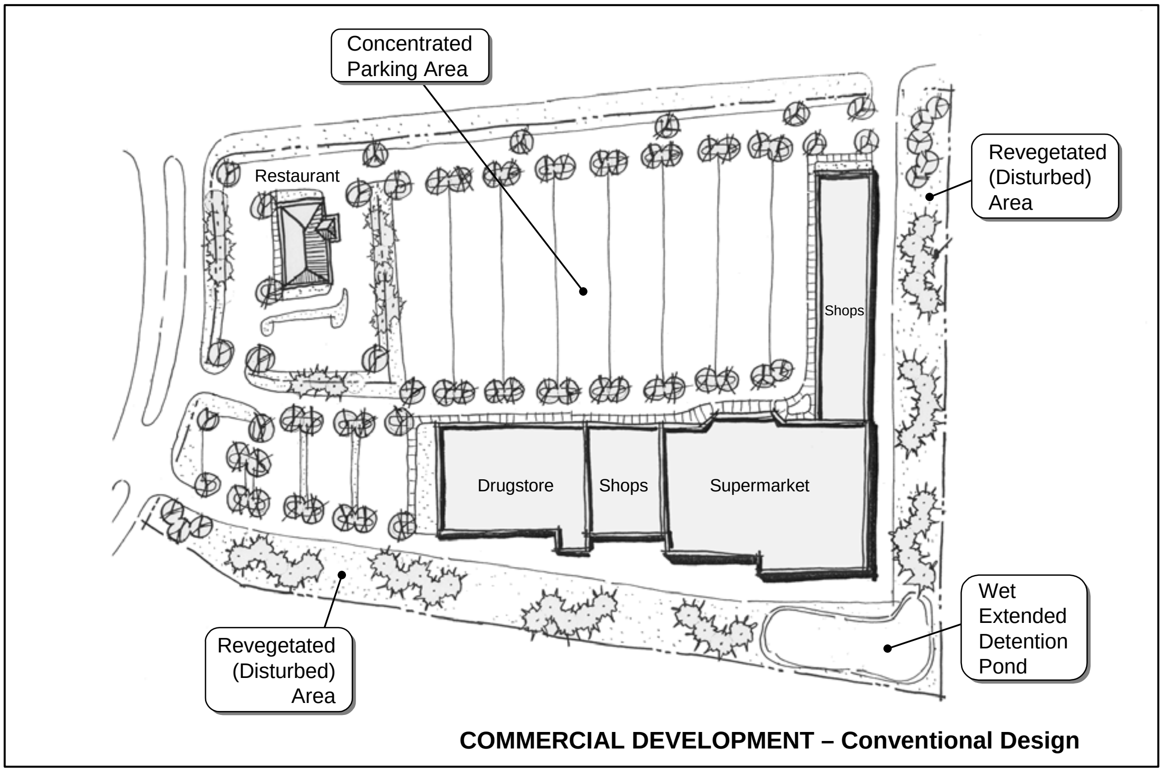
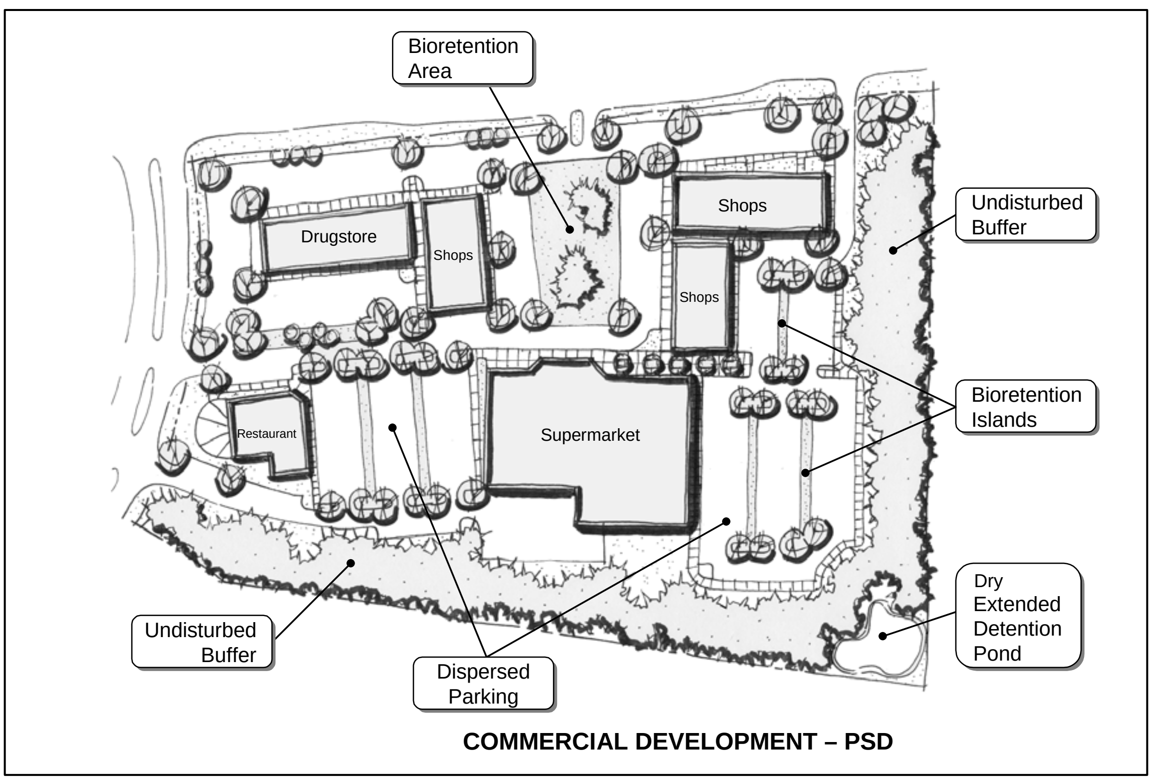


Figure 2-3 Comparison of a Traditional Commercial Development (above) with an Innovative Site Plan Developed Using Preferred Site Design Practices (below)



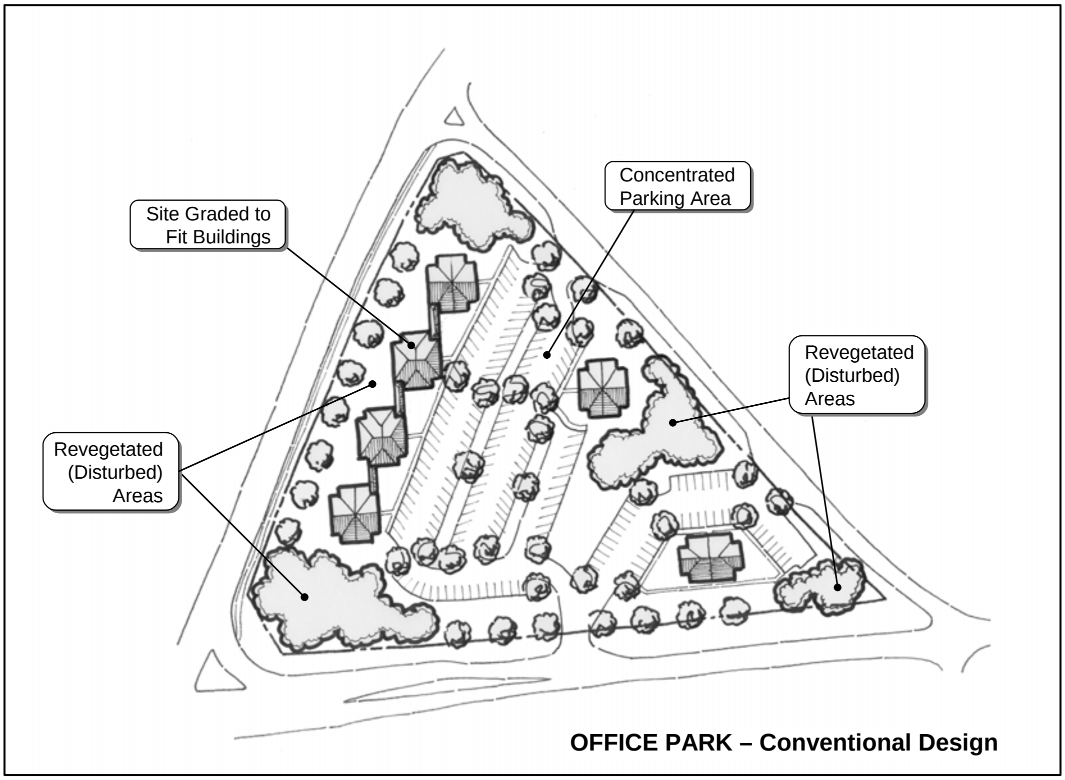


Figure 2-4 Comparison of a Traditional Office Park Design (above) with an Innovative Site Plan Developed Using Preferred Site Design Practices (below)